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OCR A Level Computer Science

H446 – Paper 1

5

Problem recognition

Unit 10 Computational thinking

PG ONLINE

Objectives

- Understand that recognising a problem is the first step in solving it
- Categorise different types of problem and solutions
- Explore different strategies for problem-solving
- Understand the concept and application of the “divide and conquer” approach

Recognising the problem

- Before a problem can be solved, it has to be recognised
- That's how all great inventions are made!
- What problems does this picture make you think of?
- Have they been solved?

I forgot my password!

- When you buy something online from a site on which you have previously registered, you will almost certainly be asked for your password
- More than one-third of customers admit to pulling out of a transaction because they can't remember their password
  - MasterCard recognised that this is a problem that needs to be solved
  - What solutions can you suggest to solve this problem?

The MasterCard solution

- When you try to purchase something, a push notification prompts you to look into your camera and blink
- That's it – you're done
  - Why do you need to blink?
  - Is this a good solution to the problem ?

Types of problems

- Some problems rely heavily on mathematics for a solution
  - Keeping a message secure by encrypting it is one problem that has been solved in many different ways
  - One method relies on having a key which is the product of a very large prime number
  - It takes a huge amount of computation time to find the numbers
- What other methods of encryption do you know about?
  - Can any encrypted message be decrypted, given enough time?

Pattern recognition

- Pattern recognition is a computational problem used in hundreds of different applications
  - Medical diagnosis
  - Speed cameras
  - Detecting a dangerously overcrowded platform on an Underground railway
- Can you think of some other uses for pattern recognition?
- Are all problems computable?

Non-computable problems

- Problems such as face-recognition or flying an airliner across the Atlantic with no human intervention may once have seemed non-computable, but are now routinely solved
- However, Alan Turing proved in 1936 that some problems are non-computable
  - Computer Science is sometimes defined as “the study of problems that are and are not computable”

Sample problem

- You are given nine sweets and four paper bags
- You are required to place an odd number of sweets in each bag
- Can you come up with a solution?
  - Note: All sweets are to be used and none eaten!

The solution

- It’s impossible!
- Can you explain why?
- If you had 2,675 sweets and 1000 paper bags, would it be possible to find a solution?
- Write down a solution if you had 99 sweets and 29 paper bags

Worksheet 5

- Try **Task 1** on the worksheet

Methods of problem solving

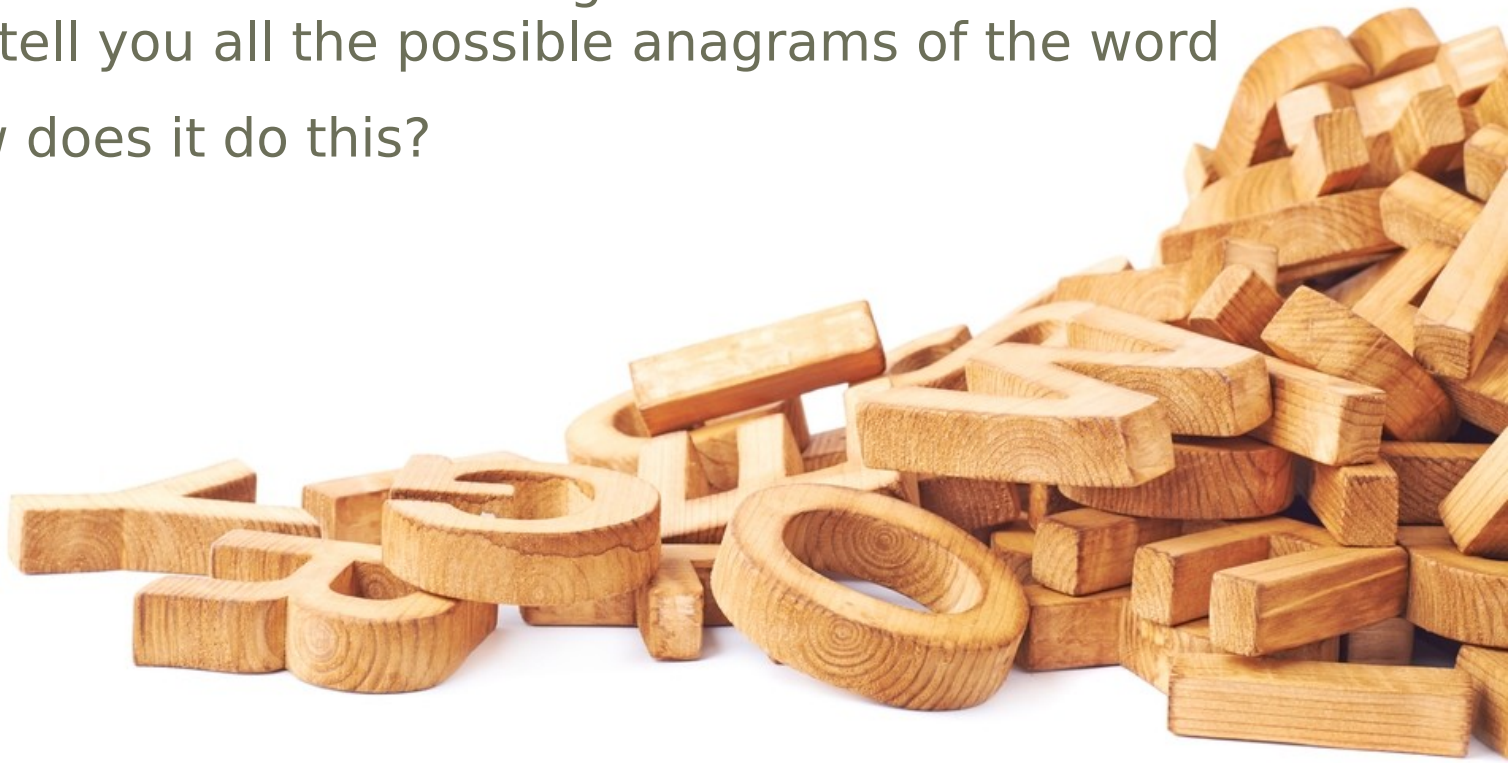
- There are many way of solving a problem, including:
  - trial and error
  - enumeration – list all cases
  - simulation
  - theoretical approach
  - creative solution
- and many more

Simulation problems

- Simulation is the process of designing a model of a real system in order to understand the behaviour of the system, and to evaluate various strategies for its operation
- Simulation applications include:
  - Financial risk analysis
  - Amusement park rides
  - Population predictions
  - Managing inventory systems
  - Queueing problems

Enumeration example

- Finding solutions to anagrams
  - Enter a word into an ‘anagram solver’ website and it will tell you all the possible anagrams of the word
  - How does it do this?

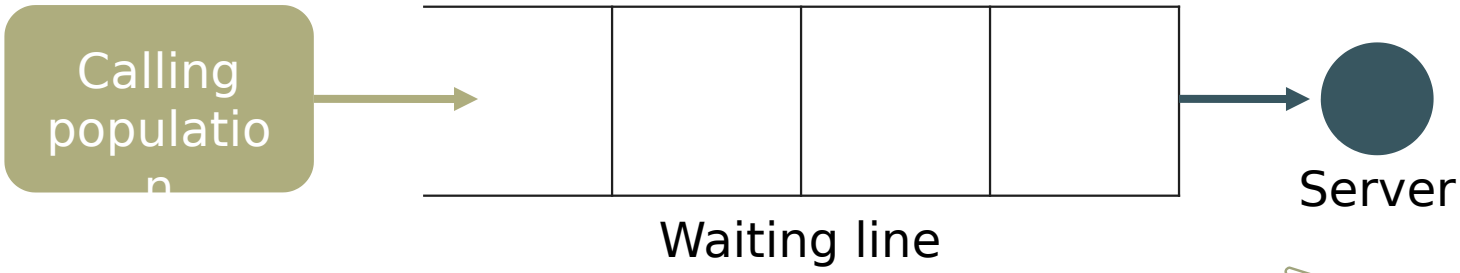


Queueing problems

- How would you find the optimum number of
  - Call centre help lines?
  - Checkouts at a new supermarket?
  - Paypoints on a toll road?
  - What other queueing problems might need to be solved?

Simulation of queueing systems

- A queueing system is described by
  - The arrival rate
  - Time between arrivals
  - Number of servers
  - Service time
- Arrival rate must be less than service rate for a stable system



Alternative approaches

- Suppose you were a motorbike rider planning a stunt jump over a ravine
  - You know the height of the jump ramp
  - You know the length of the run up to the ramp
  - How can you be sure to clear the gap?
- Would you favour a trial and error approach, or a theoretical approach?

Creative solution

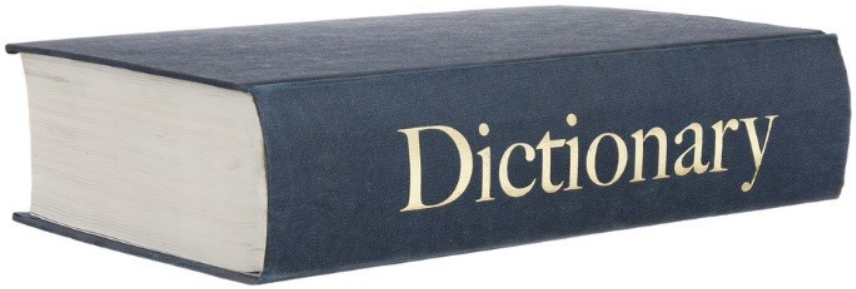
- How would you prevent any comments from Internet Trolls from reaching their intended recipients if you ran Twitter?
  - What would constitute a comment deemed to be from a troll and worthy of concealing from the recipient?

Worksheet 5

- Try **Task 2** on the worksheet

Strategies for algorithm design

- 'Divide and conquer' is a very efficient strategy
- This involves finding a solution to a sequence of smaller, related problems until the instance is small enough to be solved directly
- Suppose you want to look up the meaning of "meander" in a hard-copy dictionary
  - What w ight page?



Divide and conquer

- Open the dictionary somewhere near the middle
- If “meander” is on that page, you have found the right page
- If you are on a page with words beginning n-z, you can discard that half of the dictionary and open a page between a-m
- Continue discarding approximately half the remaining pages until you find the correct one

Binary search

- This is the principle of the binary search
- The middle name is examined first, and if that is not the name sought, half the list is discarded
  - Which items would need to be examined to find the name Zane in this list of names?

Arthur Chloe Daisy Eric Holly Jon Liam Mark Rowan Zane

Try it out!

- Ask a partner to think of a number between 1 and 100
- For each guess you make, your partner will tell you whether you are too high, too low or on the button
  - How many guesses will you need?
  - How many if the number is between 1 and 1024?
  - How many guesses, on average, using a sequential search?

Sample problem

A well-known celebrity is among a group of people at a gathering. The celebrity knows none of the other guests, but everybody knows the celebrity

- How can you identify the celebrity by repeatedly asking the question “Do you know this person?”
- The other guests may, or may not know each other

Solution

- If there are n (where n = 2 or more) people at the gathering, you can select two people from the group, and ask one of them (Person A) "Do you know this person?" (Person B)
- If A knows B, then remove A from the people who could be the celebrity. If A does not know B, remove B from the group who could be the celebrity.
- Then solve the problem for the remaining group of
  n-1 people
- Repeat until there are only 2 people left

Worksheet 1

- Now try **Tasks 3** and **4** on the worksheet

Plenary

- There is an infinite number of different real-world problems to be solved, from making this week's shopping list to deciding on the nation's best economic strategy for the next decade
- Computational thinking is a way of thinking about how to approach problems and finding optimum solutions
- Abstraction is used in problem solving to remove unnecessary details from the problem and in procedural decomposition, identifying sub-procedures necessary to solve the problem

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